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# Politicization and COVID-19 vaccine resistance in the U.S.

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## Contents

## Abstract

Science is frequently used and distorted to advance political, economic, or cultural agendas. The politicization of science can limit the positive impacts that scientific advances can offer when people reject sound and beneficial scientific advice. Politicization has undoubtedly contributed to hesitancy toward uptake of the COVID-19 vaccine. It is urgent for scientists and clinicians to better understand: (1) the roots of politicization as related to COVID-19 vaccines; (2) the factors that influence people's receptivity to scientific misinformation in politicized contexts; and (3) how to combat the politicization of science to increase the use of life-saving vaccines. This chapter explores these issues in the context of COVID-19 vaccine resistance in the United States. After briefly describing the development of the vaccines, we describe the ways in which the disease itself became politicized because of statements by political leaders and also by media accounts including social media. We then review the politicization of the vaccine at both national and international scales, variability in public acceptance of the vaccines in the United States, and response to the emergence of variants. The next section summarizes social science findings on overcoming vaccine resistance, and the concluding section outlines some of the lessons of the politicization of the disease and the vaccine for health practitioners and life scientists.

Science is frequently used and distorted to advance political, economic, or cultural agendas. In this chapter, we focus on the politicization of science, or its use to advance a particular political agenda. Politicization can occur partly

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because science "is inherently uncertain… the bottom line is that science is easy to challenge because uncertainty always exists and questioning extant knowledge is part of the research process"[1] [(p615)]. One of the primary ways that science is politicized is the emphasis of inherent uncertainties to plant doubt among the public over the existence of any scientific consensus.[2] The politicization of science can prevent scientific advances from occurring and/or limit the positive impacts that ensue when people reject sound and beneficial scientific advice.

Politicization has undoubtedly contributed to hesitancy toward COVID-19 vaccination. It is urgent for scientists and health practitioners to better understand: (1) the roots of politicization as related to COVID-19 vaccines; (2) the factors that influence people's receptivity to scientific misinformation in politicized contexts; and (3) how to combat the politicization of science to increase the use of life-saving vaccines. This chapter explores these issues in the context of COVID-19 vaccine resistance in the United States. After briefly describing the development of the vaccines, we describe the ways in which the disease itself became politicized because of statements by political leaders and media accounts, including social media. We then review the politicization of the vaccine at both national and international scales, variability in public acceptance of the vaccines in the United States, and response to the emergence of variants. The next section summarizes social science findings on overcoming vaccine resistance, and the concluding section outlines some of the lessons of the politicization of the disease and the vaccine for health practitioners and life scientists.

## 1. The development of vaccines for COVID-19

The WHO declared COVID-19 a global pandemic on March 11, 2020, leading the United States to declare COVID-19 a national emergency 2 days later. Almost immediately, on March 16, phase I of clinical trials began for "an mRNA vaccine targeting spike protein" designed by the National Institutes of Health and Moderna (m-RNa-1273); Pfizer and BioNTech announced the start of a phase I/II trial of their mRNA vaccine (BNT162) on May 5, 2020. The US Food and Drug Administration (FDA) issued emergency use authorization of the Pfizer-BioNTech vaccine on December 11, 2020, and the Moderna vaccine on December 18, 2020. Emergency use authorization was granted to the Johnson & Johnson vaccine on February 27, 2021. The Pfizer–BioNTech vaccine gained full FDA approval on August 23, 2021.

The rapid development and testing of these mRNA vaccines was made possible by previous decades of work and many millions of dollars of investment in immunology and vaccine research programs by both the federal government, through the National Institutes of Health, and private foundations such as the Bill and Melinda Gates Foundation.[3] Previous work on the severe acute respiratory syndrome (SARS), Middle East respiratory syndrome (MERS), influenza, and HIV viruses laid the foundation for strategies to neutralize these viruses, including development of antibody cocktails. The technology underlying the Pfizer/BioNTech and Moderna/NIH vaccines emerged over the last decade from university scientists working on HIV and influenza vaccines, which then sparked Zika, Ebola, and coronavirus vaccine programs at the NIH and in the pharmaceutical industry. The Moderna mRNA vaccine was made as a collaboration with the NIH's Vaccine Research Center, funded by U.S. taxpayers since 1997 to create vaccines against deadly viruses and other human diseases.[4,3]

## 2. How did the COVID-19 virus itself become politicized?

The politicization of health-related issues occurs when political identities or cues become integrated into the public discourse surrounding any topic.[5,6] This can involve news outlets emphasizing political controversy over an issue that then colors partisans' evaluations of novel scientific information. The roots of politicization surrounding COVID-19 vaccines can be attributed, at least in part, to (1) statements and visual cues by leading politicians, (2) media coverage about the nature of the virus; and (3) partisan divisions in public discourse about vaccination.[7,8]

(1) *Statements and visual cues by leading politicians and the CDC*
President Donald Trump initially downplayed the threat posed by COVID-19 and compared it to the flu in public remarks.[9] The President also labeled it a "new hoax" [and said that] "the Democrats are politicizing the coronavirus—they're politicizing it."[10] President Trump also promoted claims that the virus could be combatted by injecting or drinking disinfectant or bleach, and promoted hydroxychloroquine as a cure.[11,12] He also appeared in public without a mask and criticized his rival for the presidency, Joe Biden, for wearing one: "Did you ever see a man that likes a mask as much as him?… If I were a psychiatrist, I'd say this guy has some big issues."[13]

Politicization thus was "baked into the context of the emergent coronavirus… From the earliest alarm, Republican politicians followed Trump's lead in publicly downplaying the threat, while Democrats responded with

more concern, exhibiting different public cues."[9(p969),14] Further, portions of the American public were influenced by President Trump's messages on Twitter suggesting that the virus was a hoax, was not serious, or that unproven therapies should be used.[15–17]

In the United States, the primary agency "recognized as the nation's premiere health promotion, prevention, and preparedness agency" is the Centers for Disease Control and Prevention or the CDC.[18] Established in 1946, this agency has made significant contributions to public health in the nation through its studies of communicable and non–communicable diseases. Unfortunately, in the context of the COVID-19 pandemic, the FDA conveyed mixed messages to the public about the risks of the disease and modes of prevention. As Michael Lewis described it, the agency's relationship to disease control "had changed in ways that eliminated its need for bravery. It had begun a descent. It had replaced the flowers on its porch with fake ones and hoped no one would notice."[19(p290)] Guharoy and Krenzelok suggest that the CDC's "unquestionable record was tarnished by technical blunders, lack of leadership, and contradictory messages throughout the pandemic."[20 (p4)] They cite as examples the failure to provide a COVID-19 test kit during early stages of the pandemic and its probable acquiescence to pressure from the Trump administration "to encourage the use of unvalidated treatments."

A staff report from the Select Subcommittee on the Coronavirus Crisis commissioned by the US House of Representatives identified 47 instances of government interference: "repeatedly overruling and sidelining top scientists and undermining Americans' health to advance the President's partisan agenda."[21(p1)] Among the instances of such partisan government interference were delays in a CDC travel alert, the blocking of plans to send reusable masks to all US households in April of 2020, the lifting of shutdown orders recommended by the CDC, and the delay and censorship of scientific reports on the nature of the virus.

**(2)** *Media coverage*

Conflicting partisan messaging has been propagated by various news sources since the beginning of the outbreak. For instance, several popular right-leaning media outlets suggested that the virus was not as severe a health threat as was being portrayed. Instead, they claimed that coverage of the seriousness of the virus was misleading, a conspiracy by the Chinese government to harm the US economy, or a plot by the "deep state" to spread panic and hurt President Trump's chances for re-election. During the COVID-19 outbreak, Fox News was far more likely than CNN or MSNBC to include

phrases raising skepticism about the impacts of the virus, with language such as "normal flu," "political weapon," and "flu panic" more prevalent in their coverage from February 1 through April 30, 2020.[7,8,22]

Social media messages compounded politicization of the virus.[23,24] Stories that circulated widely on social media included false claims (such as transmission of coronavirus through mosquito bites), conspiracy theories (the virus is spread by 5G towers) and pseudoscientific health therapies (eating garlic or drinking bleach can cure the disease).[25] The speed and extent of this spread of false information via social media has been characterized as a kind of epidemic itself: a "misinfodemic."[26]

**(3)** *Partisan differences in response*

In the absence of a vaccine, governments implemented a variety of nonpharmaceutical interventions (NPIs) "such as social distancing, school closures, remote working, restrictions concerning public gatherings, quarantines, hand–washing and the use of masks to slow transmission of the disease."[27(p684)] The success of these NPIs, as with vaccinations, was affected by politicization in media coverage and communication through social media resulting in, among other things, partisan differences in the perceived seriousness of the virus and willingness to comply with NPIs.[28–33]

## 3. Politicization of the COVID-19 vaccine

Political conflict and coverage surrounding the nature and risk of the virus set the stage for segments of the public to be relatively more receptive to misinformation about COVID–19 vaccines.[34] Attitudes toward receiving a vaccine can be "understood as a continuum ranging from outright refusal to active demand for immediate uptake."[35(p1), 36,37] Since the beginning stages of testing for COVID–19 vaccines, polls indicated that a sizeable percentage of people in the United States were *vaccine resistant*, defined as unwilling to get vaccinated once one became available.[38] Many people were also *vaccine hesitant*, defined as a preference to wait for others have been vaccinated before deciding for themselves.[39,40] It is important to note that vaccine resistance/hesitancy has not been static but instead has been influenced by information, the current state of the epidemic, and a variety of individual–level characteristics.[41]

**(1)** *Coverage of vaccine development and approval*

On May 15, 2020, President Trump announced Operation Warp Speed, a public–private partnership with $10 billion in funding from Congress to enable faster development and approval of a vaccine for COVID–19.

"That means big, and it means fast," Trump stated, "A massive scientific, industrial and logistical endeavor unlike anything our country has seen since the Manhattan Project."[42] The main goal, according to the Department of Health and Human Services, was to "produce and deliver 300 million doses of safe and effective vaccines with the initial doses available by January 2021."[43] This provided support for pharmaceutical companies to conduct research and development on vaccine candidates, aid for manufacturing and storage of pre-approved vaccines, and coordination across other federal agencies to accelerate the process. Yet misinformation about COVID-19 vaccines was already widespread and "a more fraught scenario for science communication is hard to imagine: a novel vaccine, probably fast-tracked, in the middle of a highly politicized and badly mishandled pandemic."[44] The Trump administration's title for this initiative likely played into the hands of anti-vaccine groups by allowing them to frame COVID-19 vaccine trials as prioritizing speed over safety. Anthony Fauci, Director of the National Institute of Allergy and Infectious Diseases stated, "I'm a little concerned by that name because it can imply… that you're going so fast that you're skipping over important steps and are not paying enough attention to safety, which is absolutely not the case."[42]

Operation Warp Speed coincided with a US presidential campaign and election, during which the safety and efficacy of any emergency-authorized COVID-19 vaccines was the subject of media coverage driven by a focus on conflict and the partisan implications of vaccinations. China and Russia had been sharply criticized for authorizing emergency use of COVID-19 vaccines outside of clinical trials, which led to "worry that political forces—the U.S. presidential election on 3 November, nationalistic pride to 'win' a race, the need to resuscitate economies—could lead to premature and dangerous approvals…by the U.S. Food and Drug Administration."[45] President Trump also had stated that emergency authorization for a COVID-19 vaccine prior to Election Day would likely help his chances for re-election.[46] The New York Times published an article voicing concerns about an October Surprise in which the FDA might rush a vaccine's approval to please the President.[47] In addition, the vaccine was the subject of political debates over the benefits of government-mandated vaccinations, concerns over "immunization cards" that people might be required to carry, and a loss of individual rights by allowing government to make personal health decisions.[48,49] This politicization of the vaccine's approval process, and the idea that the vaccine might be released before the election, reduced the public's confidence in its safety and their intentions to get vaccinated.[50]

Vaccine development also was politicized on a national scale as China, Russia and the United States raced to be the first with an effective vaccine. Government agencies and leading news sources attributed this to "vaccine nationalism." For example, comparing coverage of vaccine development in the Global Times (China) and the New York Times (US), Abbas found that Chinese state media started "a misinformation campaign against American vaccines" while US news sources raised doubts about the strength and effectiveness of the Chinese Sinovac vaccine.[51]

**(2)** *Variability in vaccine acceptance/resistance*

Politicization surrounding COVID-19 vaccines contributed to hesitancy, resistance, and opinion polarization. In June 2020, polls showed that about 34% of the U.S. public would accept a COVID-19 vaccine, and large differences existed in opinions between Republicans Democrats.[52,53,41; 1] Those who intended to vote for President Trump were 35% more likely to say that they would not get vaccinated for COVID-19.[54] As vaccine access expanded in the spring of 2021, the proportion of Americans stating that they intended to get vaccinated rose, but still lagged among Republicans.[55] As Allcott et al. summarized it: "partisanship is a primary driver of attitudes about the pandemic and self-reported behaviors."[28(p4)]

Republicans were more likely than Democrats to believe anti-vaccine misinformation.[34] This reflected a growing skepticism among conservatives toward the scientific community in general, in part due to the rise of right-wing populist messages that pit "ordinary people" against "corrupt elites."[56,57] This distrust of experts was associated with the rejection of scientific messages about vaccines.[58] Populist rhetoric may have primed anti-intellectual considerations that made public health messages less impactful among conservatives.[59]

In this case, attention to the statements and endorsements made by trusted elite sources led to high levels of polarization. For instance, a study was conducted in late March 2021 on the effect of exposure to one of two short videos and statements endorsing COVID-19 vaccines—either from President Joe Biden or Former President Donald Trump.[55] Republicans hearing a message urging vaccination from Trump were more likely to state

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1 Several other demographic characteristics have also been associated with reported willingness to accept the COVID-19 vaccine. In general, people with less education, income, and who live in rural areas were less likely to get vaccinated for COVID-19; and, at least in the U.S., women and minorities were significantly more likely to say they would not get vaccinated.[40] Americans characterized as having high levels of religiosity are also both more likely to be misinformed about COVID-19 and also to refuse a vaccine.[111]

they would get vaccinated compared to a control group, but were less likely to state they would get vaccinated if the message came from President Biden, the out–party leader. Even for those seeking accurate information, differences in the *perceived credibility* of partisan sources could have driven the observed belief polarization occurring after exposure to identical messages from opposing partisan elites.[60] The key take–away points are that people's underlying goals, or motivations, vary across contexts and unvaccinated Republicans would be more likely to accept a COVID-19 vaccine after exposure to a pro–vaccination message endorsed by a Republican leader. Studies have also shown that people conform to the opinions of others living in the same area: a study showed that people living in areas with higher degrees of polarization were more likely to conform with others of their in–group with respect to health-behavior responses to the COVID-19 crisis.[61,2]

Human decision-making and information processing is influenced by *motivations* that color how people evaluate scientific arguments, evidence, and political information.[62–64] COVID-19 was "a disease that quickly became politicized in the United States, [and] individuals are vulnerable [to vaccine misinformation] because they tend to rely on identity affirmation rather than a systematic assessment of information" in these settings.[55] A reliance on "identity affirmation" in processing scientific information means that people often are motivated to evaluate new information in a way that protects their prior beliefs, worldviews, and social identities: when forming beliefs and making decisions, people may seek out information that supports their existing views (confirmation bias), selectively avoid or counter argue against information that challenges and existing belief or identity (disconfirmation bias), and evaluate information that is congruent with an existing belief, worldview or identity as stronger than opposing arguments (prior attitude effect).[65,66]

Politicization of the vaccine also interacted with the spread of conspiracy theories about the vaccine.[3] A conspiracy theory is an unconfirmed explanation for an event that involves a small group of actors engaging in a harmful deception for personal benefit at the expense of the collective.[67] In the case of COVID-19, conspiracy theories singled out "China, Russia, Bill

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[2]  It should be noted that this effect is conditional on the severity of the pandemic and highlights that there are ways to vitiate "biases" in information processing and reasoning.

[3]  A sizeable literature has shown that a general conspiratorial predisposition exists, independent of partisanship, that causes people to be receptive to conspiracy theories and claims and more skeptical of scientific counterclaims and recommendation.

Gates, Democrats, the 'deep state', and the pharmaceutical industry, to name a few."[68(p2)] A national survey of US adults in June 2020 showed that conspiracy theories endorsed by partisan figures have a stronger impact on audiences' levels of misinformation about COVID-19 compared to medical misinformation about the transmissibility of the virus.[68] Individuals who are more open to believing in conspiracy theories, especially on issues where there is politicization and partisan polarization, tend to be more resistant to scientific information, more open to science politicization, and less willing to engage in pro-social health behaviors.[69–72]

## 4. Emergence of variants and continued politicization

The SARS-CoV-2 virus, like all other viruses, change and evolve over time. It remains uncertain how the virus might change with respect to its infectiousness, virulence, and immune evasion.[73] At this point, the World Health Organization (WHO) has four "variants of concern" identified in the United Kingdom (alpha, September 2020), South Africa (beta, May 2020), Brazil (gamma, November 2020) and India (Delta, October 2020).[74] The WHO has also designated five other variants as "variants of interest" in addition to numerous other variants that are designated "Alerts for Further Monitoring." The list is amended frequently as new mutations are identified and documented.

As of August 2021, the delta variant had become the most prevalent because of a mutation that made it more infectious than the original virus. Because of its increased ability to spread among human populations, "almost all current viruses are descended from it … evidence is accumulating that infected people not only spread the virus more efficiently, but also faster, allowing the variant to spread even more rapidly."[73(p846)] With large numbers of people unvaccinated, the variants of the virus could become even more deadly immune to current vaccines.[75,76]

Despite a barrage of media reports on renewed spikes in deaths and hospitalizations due to COVID-19, and warnings from various celebrities and political leaders, the response to the adoption of public health measures continues to be polarized. In summer 2021, 52% of Republicans said that they had received at least one dose of the vaccine or planned to get vaccinated as soon as possible as opposed to 88% of Democrats.[77] Further evidence of this division is the fact that 17 of the 20 States with the lowest vaccination rates in summer 2021 were carried by Donald Trump in the 2020 Presidential

Election.[78] Politicization surrounding mask mandates in public spaces including classrooms and mandatory vaccinations or testing for some exemplify these ongoing divisions.

Reluctance to abide by mandatory masking edicts in public venues and classrooms became politicized early in the course of the pandemic as advice from the Centers for Disease Control and public health experts originally discouraged masks for people not showing symptoms.[79] Concerned about a possible shortage of masks, experts including Dr. Anthony Fauci, director of the National Institute of Allergy and Infectious Diseases and Dr. Jerome Adams, former surgeon general argued that face masks should be reserved for front-line medical workers.[80] When the message changed and some school districts and government authorities began mask mandates, protests erupted arguing that mask requirements impinged on personal freedom.[81] In states such as Florida, Texas and Arizona, state leaders banned mask mandates for schools, while the University System of Georgia regents warned of disciplinary action for faculty members requiring COVID mitigation measures such as distance learning or mandatory masks in classrooms.[82,83] In each such case, the anti–mask position was backed by a Republican governor and/or Republican–dominated legislature arguing that such mandates impinge on parental rights to make decisions about the health care of their children.[84]

The announcement by President Biden on September 10, 2021, that employers with 100 workers or more require their employees to get vaccinations or weekly COVID testing, was met with sharp criticism from Republicans who saw this move as "unconstitutional," "un-American" and "an assault on freedom and liberty."[85–87] At the same time, the chair of the Democratic National Committee, Jaime Harrison, enthusiastically supported this mandate, stating that the Democrats are "moving forward with protecting the American people" while the Republican response is "crazy."[88]

## 5. What does social science research conclude about promoting vaccine acceptance

To control the spread of COVID-19 through vaccination, it is imperative that communication strategies to overcome hesitancy and resistance among unvaccinated individuals and groups be developed. One strategy is to convey to the public the dangers of viral infection of themselves and others, and the value of vaccination to prevent disease and death, actions that might lead to decreased vaccination rejection. To better understand the

causal impact of messages about COVID-19 vaccines, we conducted a controlled survey experiment in May 2020 that randomly assigned 1123 respondents to one of six different message conditions.[4] The messages (treatments) highlighted positive or negative considerations about the safety of the coronavirus vaccine, information about the likelihood that other Americans would get vaccinated when a vaccine became available, and politicization of vaccination as evidenced by suggestions that liberals sought to control individuals' personal lives or by President Trump's unsupported statements that vaccine approval was rushed for political gain by Democrats and other liberals. We found that those given a message emphasizing the safety and effectiveness of the vaccine reported increased intentions to get vaccinated compared to the control group of respondents who did not read or receive any information (treatment) but were simply asked about their intentions to get vaccinated. We also found that messages that most other Americans were *not* willing to get vaccinated decreased reported intentions to get vaccinated, demonstrating the powerful impact that communicating descriptive social norms can have on individuals. In addition, messages that suggested the vaccine was being rushed for approval prior to the Presidential election decreased reported intentions to get vaccinated.[35]

Another study conducted in December 2020 and January 2021 on 24,682 unvaccinated Americans involved asking respondents to read one of five randomly assigned messages. These included whether the vaccine was recommended by the respondent's personal physician or "most scientists," two moral frames that appealed either to patriotism ("doing what is right for one's country") or preventing harm to themselves and others, or to a descriptive social norm treatment that communicated whether or not most people in one's social network were likely to take the vaccine.[89] The results showed that exposure to every message condition, except for patriotism, significantly reduced vaccine resistance. Further, the large sample offered an opportunity to explore how different subgroups responded to the different messages. Few differences in the effects of these messages on different partisan subgroups were found. These studies indicated that "multiple messaging strategies can reduce vaccine resistance." However, a key question that remains is "when are these communications most effective, and for whom?"

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[4] This was a convenience sample recruited and remunerated through Amazon's Mechanical Turk (MTurk) platform.

Scientific messages that communicate the degree of scientific consensus on any issue can also have a powerful impact on audiences and may serve as one way to combat vaccine resistance.[90,91] One study that looked at perceptions of the safety of childhood vaccines found that agreement with the statement that "90% of medical scientists agree that vaccines are safe" was the strongest predictor of support for vaccines.[92] Shifting individuals' perceptions about the level of consensus among expert scientists about the safety and efficacy of the coronavirus vaccine might ultimately lead to a cascade of pro-social health behavior, such as getting vaccinated.

Other research has explored the extent to which exposing individuals to information that warns against and refutes, or "pre-bunks," vaccine misinformation prior to actual exposure to the misinformation reduces or eliminates the effect it can exert on audiences in politicized contexts.[93] This builds on efforts to combat other forms of scientific misinformation by making respondents aware of such claims but then immediately refuting them in order to establish an initial belief that the misinformation is not to be trusted.[94–97] Although pre-bunking is a possible way of combatting vaccine misinformation prior to its politicized embedding in the public consciousness, it is not always possible to preempt the rise and spread of misinformation, especially in a transformed digital media environment.[98–100] In such cases, providing individuals with factually accurate and corrective information often can reduce political and scientific misperceptions.[101,102] In a study performed in the United States and United Kingdom, Carey et al. demonstrated that corrections reduced targeted misperceptions on incorrect beliefs—that hydroxychloroquine and antibiotics can cure COVID-19, that the virus was a bioweapon created by China or created by Bill Gates—but did not have a persistent and lasting impact on the prevalence of those same misperceptions even when survey respondents were repeatedly exposed to corrective information. On the positive side, providing factually corrective information increased the accuracy of respondents' perceptions about COVID-19 and reduced the prevalence of these misperceptions in the short-term; however, the effects of this information were "disappointingly ephemeral" on those respondents and completely disappeared over time.[103]

## 6. What does politicization mean for practitioners of science?

Online social media has facilitated the spread of rumors, conspiracy theories and misinformation at a speed and intensity unprecedented in history.[104] When combined with the politicization of science, the results can be

disastrous for objective reasoning in individual and collective decision-making.[105] What can science practitioners do to combat the deleterious impacts of politicization in the specific case of resistance to the COVID-19 vaccine? In addition to individual activities on the part of scientists themselves, there are several take-aways for life scientists and health professionals.

First, we need to recognize that science is politicized, but that such politicization has been the case throughout much of human history. From the conviction of Socrates (470–339 BC) for corrupting youth with his teachings, to Roger Bacon (1214–94) being imprisoned for finding logical inconsistencies in the Bible, to Galileo Galilei's arrest for his refusal to accept the Church's position on the nature of the solar system, scientists have struggled for independence and intellectual freedom. An account written in 2009 reports "threats from all sides of the political spectrum over the years" including restricting funding, dictating the curriculum in science classes, controlling the composition of scientific advisory committees, and reviewing or censoring scientific publications."[106(p4)] Although the speed and efficiency of transmission of science skepticism has changed with the democratization of information, the tendency to resist ideas and inventions that would be beneficial to the world has a long history.[107,108] Understanding the context of skepticism about science should increase patience with short-term setbacks and also the need for persistence even under challenging situations.

Second, scientists need to be aware of how their communications affect people and tailor their communication styles to maximize effectiveness. Decades of research on effective communication of science suggests a few principles (1) effective communication leading to constructive action requires that the communicator has earned the trust of the audience, not through status or titles, but instead through mutual respect; (2) scientific information is more likely to be acted on if technical details are accompanied by content to which the audience relates, including storytelling; (3) information should be clear, consistent, understandable and actionable.[109] Just as social media has been used in the COVID pandemic to communicate misinformation, so too can it be a tool used by the science community to correct that misinformation and to enhance trust in scientific and medical research findings.

Finally, there is a need for more collaborative cross-disciplinary work to promote rapid adoption of important scientific findings. The complexity of the COVID-19 pandemic and its politicization at local, national, and international scales points to the importance of multifaceted approaches to understanding its disease-related, pharmaceutical, economic, geographic, cognitive, and psychological components simultaneously.[110] The improvement of

COVID outcomes will only take place when global expertise gleaned from all relevant disciplines are marshaled. Life scientists and healthcare professionals will play a key role, but their work will be enhanced if they work in large-scale teams with social and psychological scientists as well as experts in policy and communication.

# References

1. Druckman JN. The crisis of politicization within and beyond science. *Nat Hum Behav*. 2017;1(9):615–617. https://doi.org/10.1038/s41562-017-0183-5.
2. Oreskes N, Conway EM. *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming*. Bloomsbury Publishing; 2011.
3. Moore JP, Wilson IA. Decades of based research paved the way for today's 'war speed; Covid-29 vaccines. *Stat*. 2021; [https://www.statnews.com/2021/01/05/basic-research-paved-way-for-warp-speed-covid-19-vaccines/. Accessed [September 30, 2021].
4. Dolgin E. The tangled history of mRNA vaccines. *Nature*. 2021;597(7876):318–324. https://doi.org/10.1038/d41586-021-02483-w.
5. Fowler EF, Gollust SE. The content and effect of politicized health controversies. *Ann Am Acad Pol Soc Sci*. 2015;658(1):155–171. https://doi.org/10.1177/0002716214555505.
6. Lupia A. Communicating science in politicized environments. *Proc Natl Acad Sci*. 2013;110(Supplement_3):14048–14054. https://doi.org/10.1073/pnas.1212726110.
7. Hart PS, Chinn S, Soroka S. Politicization and polarization in COVID-19 news coverage. *Sci Commun*. 2020;42(5):679–697. https://doi.org/10.1177/1075547020950735.
8. Motta M, Stecula D, Farhart C. How right-leaning media coverage of COVID-19 facilitated the spread of misinformation in the early stages of the pandemic in the U.S. *Can J Pol Sci*. 2020;53(2):335–342. https://doi.org/10.1017/S0008423920000396.
9. Gollust SE, Nagler RH, Fowler EF. The emergence of COVID-19 in the US: A public health and political communication crisis. *J Health Politics Policy Law*. 2020;45 (6):967–981. https://doi.org/10.1215/03616878-8641506.
10. Cook N, Choi M. Trump rallies his base to treat coronavirus as a 'hoax'. *Politico*. 2020; [February 28, 2020. www.politico.com/news/2020/02/28/trump-south-carolina-rally-coronavirus-118269. Accessed [September 30, 2021].
11. Kahane LH. Politicizing the mask: Political, economic and demographic factors affecting mask wearing behavior in the USA. *Eastern Econ J*. 2021;47(2):163–183. https://doi.org/10.1057/s41302-020-00186-0.
12. Mackey TK, Purushothaman V, Haupt M, Nali MC, Li J. Application of unsupervised machine learning to identify and characterise hydroxychloroquine misinformation on twitter. *The Lancet Digital Health*. 2021;3(2):e72–e75. https://doi.org/10.1016/S2589-7500(20)30318-6.
13. LeBlanc P. Trump mocks Biden for wearing mask: 'Did you ever see a man that likes a mask as much as him?'. *CNN*. 2020; [https://edition.cnn.com/2020/09/03/politics/trump-biden-coronavirus- mask/index.html. Accessed [September 30, 2021].
14. Hao F, Shao W, Huang W. Understanding the influence of contextual factors and individual social capital on American public mask wearing in response to COVID–19. *Health Place*. 2021;68:102537. https://doi.org/10.1016/j.healthplace.2021.102537.
15. Hornsey MJ, Finlayson M, Chatwood G, Begeny CT. Donald Trump and vaccination: The effect of political identity, conspiracist ideation and presidential tweets on vaccine hesitancy. *J Exp Soc Psychol*. 2020;88:103947. https://doi.org/10.1016/j.jesp.2019.103947.

16. Ugarte DA, Cumberland WG, Flores L, Young SD. Public attitudes about COVID-19 in response to president Trump's social media posts. *JAMA Netw Open*. 2021;4(2): e210101. https://doi.org/10.1001/jamanetworkopen.2021.0101.

17. Niburski K, Niburski O. Impact of Trump's promotion of unproven COVID-19 treatments on social media and subsequent internet trends: Observational study. *J Med Internet Res*. 2020;22(11):e20044. https://doi.org/10.2196/20044.

18. Centers for Disease Control and Prevention. *Our History*. CDC Healthy Schools; 2021 [https://www.cdc.gov/healthyschools/bam/basics/our-history.htm. Accessed [September 30, 2021].

19. Lewis M. *The Premonition: A Pandemic Story*. UK: Penguin; 2021.

20. Guharoy R, Krenzelok EP. Lessons from the mismanagement of the COVID-19 pandemic: A blueprint to reform CDC. *Am J Health Syst Pharm*. 2021;78 (18):1739–1741. https://doi.org/10.1093/ajhp/zxab209.

21. United States House of Representatives, Select Subcommittee on the Coronavirus Crisis. *The Trump administration's Pattern of Political Interference in the nation's Coronavirus Response*; 2020. https://coronavirus.house.gov/sites/democrats.coronavirus.house.gov/files/10.2. 20%20Political%20Interference%20Report%20%281%29.pdf. Accessed [September 30, 2021].

22. Ash E, Galletta S, Hangartner D, Margalit Y, Pinna M. The effect of fox news on health behavior during COVID-19. *SocArXiv*. 2020. https://doi.org/10.31235/osf.io/abqe5.

23. Megget K. Even covid-19 can't kill the anti-vaccination movement. *BMJ*. 2020; m2184. https://doi.org/10.1136/bmj.m2184. Published online June 4.

24. Pian W, Chi J, Ma F. The causes, impacts and countermeasures of COVID-19 "Infodemic": A systematic review using narrative synthesis. *Inf Process Manag*. 2021;58(6):102713. https://doi.org/10.1016/j.ipm.2021.102713.

25. Naeem SB, Bhatti R, Khan A. An exploration of how fake news is taking over social media and putting public health at risk. *Health Info Libr J*. 2021;38(2):143–149. https://doi.org/10.1111/hir.12320.

26. Chou W-YS, Gaysynsky A, Vanderpool RC. The COVID-19 misinfodemic: Moving beyond fact-checking. *Health Educ Behav*. 2021;48(1):9–13. https://doi.org/10.1177/1090198120980675.

27. Soveri A, Karlsson LC, Antfolk J, Lindfelt M, Lewandowsky S. Unwillingness to engage in behaviors that protect against COVID-19: The role of conspiracy beliefs, trust, and endorsement of complementary and alternative medicine. *BMC Public Health*. 2021;21(1):684. https://doi.org/10.1186/s12889-021-10643-w.

28. Allcott H, Boxell L, Conway J, Gentzkow M, Thaler M, Yang D. Polarization and public health: Partisan differences in social distancing during the coronavirus pandemic. *J Public Econ*. 2020;191:104254. https://doi.org/10.1016/j.jpubeco.2020. 104254.

29. Gadarian SK, Goodman SW, Pepinsky TB. Partisanship, health behavior, and policy attitudes in the early stages of the COVID-19 pandemic. *PLoS ONE*. 2021;16(4): e0249596. https://doi.org/10.1371/journal.pone.0249596.

30. Simonov A, Sacher S, Dubé J-P, Biswas S. The persuasive effect of fox news: Non-compliance with social distancing during the Covid-19 pandemic. *National Bureau of Economic Research*. 2020;w27237. https://doi.org/10.3386/w27237.

31. Barrios J, Hochberg Y. Risk perception through the lens of politics in the time of the COVID-19 pandemic. *National Bureau of Economic Research*. 2020. https://doi.org/10.3386/w27008.

32. Grossman G, Kim S, Rexer JM, Thirumurthy H. Political partisanship influences behavioral responses to governors' recommendations for COVID-19 prevention in the United States. *Proc Natl Acad Sci U S A*. 2020;117(39):24144–24153. https://doi.org/10.1073/pnas.2007835117.

33. Makridis C, Rothwell JT. The real cost of political polarization: Evidence from the COVID-19 pandemic. *SSRN Journal*. 2020. https://doi.org/10.2139/ssrn.3638373. Published online.

34. Motta M. Republicans, not democrats, are more likely to endorse anti-vaccine misinformation. *Am Politics Res*. 2021;49(5):428–438. https://doi.org/10.1177/1532673X211022639.

35. Palm R, Bolsen T, Kingsland JT. The effect of frames on COVID-19 vaccine resistance. *Front Polit Sci*. 2021;3:661257. https://doi.org/10.3389/fpos.2021.661257.

36. Dubé E, Laberge C, Guay M, Bramadat P, Roy R, Bettinger JA. Vaccine hesitancy: An overview. *Hum Vaccin Immunother*. 2013;9(8):1763–1773. https://doi.org/10.4161/hv.24657.

37. Larson HJ, Jarrett C, Eckersberger E, Smith DMD, Paterson P. Understanding vaccine hesitancy around vaccines and vaccination from a global perspective: A systematic review of published literature, 2007–2012. *Vaccine*. 2014;32(19):2150–2159. https://doi.org/10.1016/j.vaccine.2014.01.081.

38. Lazer D, Ognyanova K, Green J, et al. The COVID states project #47: Update on COVID-19 vaccine attitudes among healthcare workers. *Open Science Framework*. 2021. https://doi.org/10.31219/osf.io/a352z.

39. Simonson MD, Baum M, Lazer D, et al. The COVID states project #45: Vaccine hesitancy and resistance among parents. *Open Science Framework*. 2021. https://doi.org/10.31219/osf.io/e95bc.

40. Lin C, Tu P, Beitsch LM. Confidence and receptivity for COVID-19 vaccines: A rapid systematic review. *Vaccine*. 2020;9(1):16. https://doi.org/10.3390/vaccines9010016.

41. Loomba S, de Figueiredo A, Piatek SJ, de Graaf K, Larson HJ. Measuring the impact of COVID-19 vaccine misinformation on vaccination intent in the UK and USA. *Nat Hum Behav*. 2021;5(3):337–348. https://doi.org/10.1038/s41562-021-01056-1.

42. Weixel N. Some worry 'operation warp speed' plays into anti-vaccination movement's hands. *The Hill*. 2020; [https://thehill.com/policy/healthcare/500213-some-worry-operation-warp-speed-plays-into-anti-vaccination-movements-hands. Accessed [September 30, 2021].

43. US Department of Health and Human Services. *Fact Sheet: Explaining Operation Warp Speed*; 2020 [November 10, 2020. Accessed [September 30, 2021].

44. Zhang S. We don't even have a COVID-19 vaccine, and yet the conspiracies are here. *The Atlantic*. 2021; [https://www.theatlantic.com/science/archive/2020/05/covid-19-vaccine-skeptics-conspiracies/611998/. Accessed [September 30, 2021].

45. Cohen J. Here's how the U.S. could release a COVID-19 vaccine before the election—And why that scares some. *Science*. 2020. https://doi.org/10.1126/science.abe5150. Published online August 28.

46. Irfan U. Why it's unlikely we'll have a COVID-19 vaccine before election day. *Vox*. 2020; [https://www.vox.com/2020/8/20/21359026/coronavirus-vaccine-COVID-19-when-october-surprise-election-trump Accessed [September 30, 2021].

47. Emanuel EJ, Offit PA. Could trump turn a vaccine into a campaign stunt. *New York Times*. 2020; [https://www.nytimes.com/2020/06/08/opinion/trump-coronavirus-vaccine.html. Accessed [September 30, 2021].

48. Lederman M, Mehiman MJ, Youngner S. Defeat COVID-19 by requiring vaccination for all. It's not un-American, it's patriotic. *USA Today*. 2020; [https://www.usatoday.com/story/opinion/2020/08/06/stop-coronavirus-compulsory-universal-vaccination-column/3289948001/. Accessed [September 30, 2021].

49. Dougherty MB. Vaccine passports are a terrible idea. *Natl Rev*. 2021; [https://www.nationalreview.com/2021/03/vaccine-passports-are-a-terrible-idea/. Accessed [September 30, 2021].

50. Bokemper SE, Huber GA, Gerber AS, James EK, Omer SB. Timing of COVID-19 vaccine approval and endorsement by public figures. *Vaccine*. 2021;39(5):825–829. https://doi.org/10.1016/j.vaccine.2020.12.048.

51. Abbas AH. Politicizing COVID-19 vaccines in the press: A critical discourse analysis. *Int J Semiot Law Published online July*. 2021;10. https://doi.org/10.1007/s11196-021-09857-3.

52. Thigpen CL, Funk C. *Most Americans Expect a COVID-19 Vaccine within a Year; 72% Say they Would Get Vaccinated*. Pew Research Center; 2021 [https://www.pewresearch.org/fact-tank/2020/05/21/most-americans-expect-a-covid-19-vaccine-within-a-year-72-say-they-would-get-vaccinated/. Accessed [September 30, 2021].

53. Tyson A, Johnson C, Funk C. *U.S. Public Now Divided over whether to Get COVID-19 Vaccine*. Pew Research; 2020 [https://www.pewresearch.org/science/2020/09/17/u-s-public-now-divided-over-whether-to-get-covid-19-vaccine/. Accessed [September 30, 2021].

54. Callaghan T, Moghtaderi A, Lueck JA, et al. Correlates and disparities of COVID-19 vaccine hesitancy. *Soc Sci Med*. 2020;272:113638. https://doi.org/10.1016/j.socscimed.2020.113638.

55. Pink SL, Chu J, Druckman J, Rand DG, Willer R. Elite party cues increase vaccination intentions among republicans. *PsyArXiv*. 2021. https://doi.org/10.31234/osf.io/f9jq5.

56. Gauchat G. Politicization of science in the public sphere: A study of public trust in the United States, 1974 to 2010. *Am Sociol Rev*. 2012;77(2):167–187. https://doi.org/10.1177/0003122412438225.

57. Oliver JE, Rahn WM. Rise of the *Trumpenvolk*: Populism in the 2016 election. *Ann Am Acad Pol Soc Sci*. 2016;667(1):189–206. https://doi.org/10.1177/0002716216662639.

58. Motta M. Can a COVID-19 vaccine live up to Americans' expectations? A conjoint analysis of how vaccine characteristics influence vaccination intentions. *Soc Sci Med*. 2021;272:113642. https://doi.org/10.1016/j.socscimed.2020.113642.

59. Pickup M, Stecula D, Van Der Linden C. Novel coronavirus, old partisanship: COVID-19 attitudes and behaviours in the United States and Canada. *Canadian Journal of Political Science/Revue*. 2020 Jun;53(2):357–364.

60. Druckman JN, McGrath MC. The evidence for motivated reasoning in climate change preference formation. *Nature Clim Change*. 2019;9(2):111–119. https://doi.org/10.1038/s41558-018-0360-1.

61. Druckman J, Klar S, Krupnikov Y, Levendusky M, Ryan JB. The political impact of affective polarization: How partisan animus shapes COVID-19 attitudes. *PsyArXiv*. 2020. https://doi.org/10.31234/osf.io/ztgpn.

62. Bolsen T, Palm R. Motivated reasoning and political decision making. In: *Oxford Research Encyclopedia of Politics*. Oxford University Press; 2019. https://doi.org/10.1093/acrefore/9780190228637.013.923.

63. Kunda Z. The case for motivated reasoning. *Psychol Bull*. 1990;108(3):480–498. https://doi.org/10.1037/0033-2909.108.3.480.

64. Sylvester SM. COVID-19 and motivated reasoning: The influence of knowledge on COVID-related policy and health behavior. *Soc Sci Q*. 2021. https://doi.org/10.1111/ssqu.12989. Published online May 25, 2021:ssqu.12989.

65. Bayes R, Druckman JN, Goods A, Molden DC. When and how different motives can drive motivated political reasoning. *Polit Psychol*. 2020;41(5):1031–1052. https://doi.org/10.1111/pops.12663.

66. Kahan DM, Jenkins-Smith H, Braman D. Cultural cognition of scientific consensus. *J Risk Res*. 2011;14(2):147–174. https://doi.org/10.1080/13669877.2010.511246.

67. Douglas KM, Uscinski JE, Sutton RM, et al. Understanding conspiracy theories. *Polit Psychol*. 2019;40(S1):3–35. https://doi.org/10.1111/pops.12568.

68. Enders AM, Uscinski JE, Klofstad C, Stoler J. The different forms of COVID-19 misinformation and their consequences. *HKS Misinfo Review*. 2020. https://doi.org/10.37016/mr-2020-48. Published online November 12.

69. Bolsen T, Palm R, Kingsland JT. Framing the origins of COVID-19. *Sci Commun*. 2020;42(5):562–585. https://doi.org/10.1177/1075547020953603.

70. Flynn DJ, Nyhan B, Reifler J. The nature and origins of misperceptions: Understanding false and unsupported beliefs about politics. *Adv Exp Soc Psychol*. 2017;38:127–150. https://doi.org/10.1111/pops.12394.

71. Miller JM, Saunders KL, Farhart CE. Conspiracy endorsement as motivated reasoning: The moderating roles of political knowledge and trust. *Am J Pol Sci*. 2016;60:824–844.

72. Uscinski JE, Parent JM. *American Conspiracy Theories*. Oxford University Press; 2014. https://doi.org/10.1093/acprof:oso/9780199351800.001.0001.

73. Kupferschmidt K. Evolving threat. *Science*. 2021;373(6557):844–849. https://doi.org/10.1126/science.373.6557.844.

74. World Health Organization. *Tracking SARS-CoV-2 Variants*; 2021 [https://www.who.int/en/activities/tracking-SARS-CoV-2-variants/. Accessed [September 30, 2021].

75. Telenti A, Arvin A, Corey L, et al. After the pandemic: Perspectives on the future trajectory of COVID-19. *Nature*. 2021;596(7873):495–504. https://doi.org/10.1038/s41586-021-03792-w.

76. Rochman ND, Wolf YI, Faure G, Mutz P, Zhang F, Koonin EV. Ongoing global and regional adaptive evolution of SARS-CoV-2. *Proc Natl Acad Sci U S A*. 2021;118(29). https://doi.org/10.1073/pnas.2104241118, e2104241118.

77. Hamel L, Lopes L, Kearney A, Sparks G, Stokes M, Brodie M. KFF Covid-19. *Vaccine Monitor*. 2021; [June 30, 2021. https://www.kff.org/coronavirus-covid-19/poll-finding/kff-covid-19-vaccine-monitor-june-2021/. Accessed [September 30, 2021].

78. Galston WA. What drives GOP resistance to vaccines? *Wall Street Journal*. 2021; [https://www.wsj.com/articles/what-drives-gop-resistance-to-vaccines-11623190392. Accessed [September 30, 2021].

79. Cohan A. *Timeline: Changes to CDC Mask Guidelines since the Pandemic Began*. Boston Herald; 2021 [https://www.bostonherald.com/2021/07/27/timeline-changes-to-cdc-mask-guidelines-since-the-pandemic-began/. Accesssed [September 30, 2021].

80. Ellis R. Ex-surgeon general: CDC mask guidance may be 'wrong'. *WebMD News Brief*. 2021; [https://www.webmd.com/lung/news/20210720/ex-surgeon-general--says-cdc-mask-guidance-may-be-wrong. Accessed [September 30, 2021].

81. Aratani L. How did face masks become a political issue in America. *The Guardian*. 2020; [https://www.theguardian.com/world/2020/jun/29/face-masks-us-politics-coronavirus. Accessed [September 30, 2021].

82. Lombardo C. In Florida, Texas and Arizona, defiant school leaders are sticking with mask mandates. *GPB News*. 2021; [https://www.gpb.org/news/back-school-live-updates/2021/08/18/in-florida-texas-and-arizona-defiant-school-leaders-are. Accessed [September 30, 2021].

83. Stirgus E. Georgia university system leader defends COVID prevention methods. *Atlanta Journal Constitution*. 2021; [https://www.ajc.com/education/georgia-university-system-leader-defends-covid-prevention-methods/R3TGI55Q6RCDDO3CDAYAXWDSGA/. Accessed [September 30, 2021].

84. Camera L. GOP governors double down on orders barring mask mandates in schools. *US News*. 2021; [https://www.usnews.com/news/education-news/articles/2021-08-10/gop-governors-double-down-on-orders-barring-mask-mandates-in-schools. Accessed [September 30, 2021].

85. Morris K. Republicans explode with fury over Biden vaccine mandate: 'Absolutely unconstitutional.'. *Fox News*. 2021; [https://www.foxnews.com/politics/republicans-respond-to-vaccine-mandates-issued-by-biden-absolutely-unconstitutional. Accessed [September 30, 2021].

86. Blake A. *The GOP's Halting, Uneven Journey toward Becoming the Anti-Vaccine Mandate Party*. Washington Post; 2021 [https://www.washingtonpost.com/politics/2021/09/11/gops-halting-journey-opposing-vaccine-mandates/. Accessed [September 30, 2021].

87. Stacey K. Republicans threaten to block Biden's "dictatorial" Covid vaccine mandate. *Financial Times*. 2021; [https://www.ft.com/content/144be751-f69a-4d20-871c-c191c2b2d4f9. Accessed [September 30, 2021].

88. Capehart J. DNC chair: GOP reaction to Biden vaccine mandate is "unhinged.". *MSNBC interview*. 2021; [https://www.youtube.com/watch?v=J0XYUfQhhIw. Accessed [September 30, 2021].

89. Green J, Druckman J, Baum M, et al. *Using general messages to persuade on a politicized scientific issue*. Working Paper; 2021.

90. Lewandowsky S, Gignac GE, Vaughan S. The pivotal role of perceived scientific consensus in acceptance of science. *Nat Clim Change*. 2013;3(4):399–404. https://doi.org/10.1038/nclimate1720.

91. van der Linden S. The gateway belief model (GBM): A review and research agenda for communicating the scientific consensus on climate change. *Curr Opin Psychol*. 2021. https://doi.org/10.1016/j.copsyc.2021.01.005.

92. van der Linden SL, Clarke CE, Maibach EW. Highlighting consensus among medical scientists increases public support for vaccines: Evidence from a randomized experiment. *BMC Public Health*. 2015;15(1):1207. https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-015-2541-4.

93. Motta M, Sylvester S, Callaghan T, Lunz-Trujillo K. Encouraging COVID-19 vaccine uptake through effective health communication. *Front Polit Sci*. 2021;3:630133. https://doi.org/10.3389/fpos.2021.630133.

94. Bolsen T, Druckman JN. Counteracting the politicization of science. *J Commun*. 2015;65(5):745–769. https://doi.org/10.1111/jcom.12171.

95. Bolsen T, Druckman JN. Do partisanship and politicization undermine the impact of a scientific consensus message about climate change? *Group Process Intergr Relat*. 2018;21(3):389–402. https://doi.org/10.1177/1368430217737855.

96. Cook J, Lewandowsky S, Ecker UKH. Neutralizing misinformation through inoculation: Exposing misleading argumentation techniques reduces their influence. *PLoS ONE*. 2017;12(5):e0175799. https://doi.org/10.1371/journal.pone.0175799.

97. van der Linden S, Leiserowitz A, Rosenthal S, Maibach E. Inoculating the public against misinformation about climate change. *Global Challenges*. 2017;1(2):1600008.

98. Iyengar S, Massey DS. Scientific communication in a post-truth society. *Proc Natl Acad Sci U S A*. 2019;116(16):7656–7661. https://doi.org/10.1073/pnas.1805868115.

99. Lazer DMJ, Baum MA, Benkler Y, et al. The science of fake news. *Science*. 2018;359(6380):1094–1096. https://doi.org/10.1126/science.aao2998.

100. Levy J, Bayes R, Bolsen T, Druckman JN. Science and the politics of misinformation. In: Tumber H, Waisbord S, eds. *The Routledge Companion to Media Disinformation and Populism*. 1st ed. Routledge; 2021. https://doi.org/10.4324/9781003004431.

101. Nyhan B, Reifler J, Richey S, Freed GL. Effective messages in vaccine promotion: A randomized trial. *Pediatrics*. 2014;133(4):e835–e842. https://doi.org/10.1542/peds.2013-2365.

102. Nyhan B, Reifler J. When corrections fail: The persistence of political misperceptions. *Polit Behav*. 2010;32(2):303–330. https://doi.org/10.1007/s11109-010-9112-2.

103. Carey JM, Guess AM, Loewen PJ, Merkley E, Nyhan B, Phillips JB, Reifler J. The ephemeral effects of fact-checks on COVID-19 misperceptions: Evidence from the US, Great Britain, and Canada. September 30, 2021. Working paper.

104. Van Bavel JJ, Baicker K, Boggio P, et al. Using social and Behavioural science to support COVID-19 pandemic response. *PsyArXiv*. 2020. https://doi.org/10.31234/osf.io/y38m9.

105. Druckman JN, Ognyanova K, Baum MA, et al. The role of race, religion, and parti-sanship in misperceptions about COVID-19. *Group Process Intergr Relat*. 2021;24 (4):638–657. https://doi.org/10.1177/1368430220985912.
106. Resnik DB. *Playing Politics with Science: Balancing Scientific Independence and Government Oversight*. Oxford University Press on Demand; 2009.
107. Burke J. *The Day the Universe Changed*. Boston: MA: Little and Brown; 1995.
108. Kuhn T. *The Structure of Scientific Revolutions*. 2nd ed. Chicago, IL: University of Chicago Press; 1970.
109. Campbell N, Roper-Fetter K, Yoder M. *Principles of Risk Communication: A Guide to Communicating with Socially Vulnerable Populations across the Disaster Lifecycle*. Boulder, CO: Natural Hazards Center, University of Colorado Boulder; 2021.
110. Norton A, Olliaro P, Sigfrid L, et al. Long COVID: Tackling a multifaceted condition requires a multidisciplinary approach. *Lancet Infect Dis*. 2021;21(5):601–602. https://doi.org/10.1016/S1473-3099(21)00043-8.
111. Rutjens BT, van der Linden S, van der Lee R. Science skepticism in times of COVID-19. *Group Process Intergr Relat*. 2021;24(2):276–283. https://doi.org/10.1177/1368430220981415.